DESIGN OF TWO STROKE SI LINEAR ENGINE WITH SPRING MECHANISM

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SUPERVISOR DECLARATION

I hereby declare that I have read this project report and in my opinion this project report is sufficient in terms of scope and quality for the award of Bachelor in Mechanical Engineering with Automotive Engineering.

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Date : ……..

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Date : ……

Signature : ……..
Name of Panel : ……..
Date : ……..

DECLARATION

I declare this thesis that was entitled “Design of Two Stroke SI Linear Engine with Spring Mechanism” is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : ……

Name : MOHD FAIZAL BIN MOHD PAUZI

Date : ……

DEDICATION

To my beloved parents, Mr. Mohd Pauzi Bin Mohd Tahir and Mdm. Normah Binti Awaludin, other siblings, family and friends, without whom his/her efforts in encouraging and supporting my dream to continue my study in the higher education of Mechanical Engineering field. And all the staffs of Faculty Mechanical Engineering from Universiti Malaysia Pahang especially my supervisor Prof Madya Dr Rosli Bin Abu Bakar and my co-supervisor Mr. Aguk Zuhdi Muhammad Fathallah for giving me priceless knowledges in order to accomplish this project.

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ABSTRACT

The objectives of this research project is to design the spring mechanism of single cylinder two stroke SI linear engine, to analyze the stress of spring mechanism of linear engine and draw the single cylinder two stroke SI linear engine. The problem arise when the modern control technology that available today is expensive to be used with small linear engine and spring is proposed to solve the related problem of piston motion control for this project. The design of the linear engine with spring mechanism for this project is based on conventional two-stroke engine. The modification is made for the crankcase, crankshaft, and connecting rod of conventional two-stroke engine with new crankcase, spring and new connecting rod of linear engine. The SI linear engine with spring mechanism is modeled by using Solid works software and the spring software is used to design the spring for this linear engine for this project.

ABSTRAK

Projek Sarjana Muda ini bertujuan mereka satu enjin dua lejang yang menggunakan spring bagi menggantikan “Crankshaft” enjin dua lejang yang asal. Masalah timbul apabila teknologi sistem kawalan terbaru untuk mengawal pergerakan piston yang terdapat di pasaran sekarang adalah terlalu mahal apabila teknologi ini hendak digunakan untuk menggantikan “Crankshaft” bagi enjin dua lejang dalam projek ini. Reka bentuk untuk enjin dua lejang bagi projek ini adalah direka berdasarkan enjin dua lejang yang asal. Pengubahsuaian dibuat ke atas enjin dua lejang yang asal adalah pada bahagian “Crankcase”, “Crankshaft” dan juga “Connecting Rod” digantikan dengan “Crankcase”, “Crankshaft” dan juga “Connecting Rod “ enjin yang baru. Enjin bagi projek sarjana muda ini di reka menggunakan perisian Solid work manakala perisian mereka spring digunakan dalam proses untuk mereka spring bagi enjin untuk projek ini.

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LIST OF SYMBOLS

d	Cylinder Bore
A	Piston Area
L	Stroke
Vs	Displacement or Swept Volume
N	Number of cylinders in Engine
Vc	Clearance Volume
r	Compression Ratio
V_T	Cylinder Volume When the Piston is at the Bottom Dead Centre
T	Temperature
n_C	Number of Spring End
n_G	Ground Coils of Spring
S_s	Desired level of safety of a spring exposed to static loading
S_f	Desired level of safety of a spring exposed to fatigue loading
G	Modulus of elasticity at operational temperature
P	Density
S_u	Ultimate tensile strength
τ_A	Permissible torsional stress
τ_e	Ultimate fatigue strength in shear
τ_f	Fatigue strength by finite life

LIST OF ABBREVIATION

TDC	Top Dead Centre
IDC	Inner Dead Centre
BDC	Bottom Dead Centre
ODC	Outer Dead Centre
IMEP	Indicative Mean Effective Pressure

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CHAPTER 1

INTRODUCTION

1.1 Project Background

The conventional two stroke engine is mounted with the crankshaft. Crankshaft is a device, which converts the up and down movement of the piston into rotary motion. This shaft is presented at the bottom of an engine and its main function is to rotate the pistons in a circular motion. In order to make this engine become linear engine which is a engine that do not use the crankshaft to control the piston motion but it is a result of the interaction of forces from the combustion cylinder gases, a rebound device and a load device, the crankshaft is substituted with the new kind of the connecting rod and also coupled with spring. The new connecting rod and spring in this project are defined as spring mechanism. This new kind of connecting rod and spring are used in the linear engine which functioning same as the crankshaft of the conventional two stroke engine except that the movement of the new connecting rod and spring is linear compare to crankshaft moves in rotation. So, this project focus more on the design of the spring at early stage and after the spring design is finished, the best design of the spring is selected, then the project continue to the stage of linear engine design. The linear engine design is the same as the conventional of the two stroke engine except that the modification is made at the crankcase, crankshaft of the conventional engine. The spring of linear engine is designed by using Mitcalc- Helical Compression Spring Version 1.12. The input parameters used in the designed of the spring based on the performance of the linear engine in the form of force which is subjected to the spring. The performance of the linear engine is obtained from GT-Power software. The engine which is simulated in

GT-Power environment is actually conventional two stroke engine but the conventional two stroke engine can be considered as linear engine because the modification has been made at the friction factor of the conventional two stroke engine. The usage of spring for SI linear engine on this project makes the working principle of the linear engine simple. Apart from that, if the design process success the cost to fabricate this linear engine is cheaper than the other linear engine. It is because this SI linear engine uses spring that work as rebound device for this engine that no need the usage of electricity compare to the other linear engine such as single piston hydraulic free piston engine. The rebound device for this linear engine type requires supply of electric power to make it function. This linear engine latter will be used with linear electric generator for producing the electric.

1.2 Problem Statement

The main challenge of free piston engine is the piston motion control as the engine does not have a crankshaft to limit the dead centre of the piston motion, other means of control must be introduced in order to avoid excessive in cylinder gas pressures, the piston hitting the cylinder head, while at the same time ensure a sufficiently high compression ratio for fuel spark ignition and efficient combustion. The control challenges that associated with the concept can be treated by using modern control technology such as hydraulic cylinder and a gas filled bounce chamber. However, the problem arises when that modern control technology is very expensive to be used with the small linear engine and other mean of piston motion control need to be figured out. The spring is used as piston motion control for this project because it is simple, cheap and can also solve the related problem with free piston engine if thorough study is conducted.

1.3 Objectives

The objectives of this project are, design the spring for the linear engine, determine the best spring design for the linear engine and lastly, design the single cylinder of two stroke SI linear engine with spring mechanism.

1.4 Project Scopes

The scopes for this project are, obtain data of linear engine performance and measure the dimension design the spring for the linear engine for the first project stage. After that, design the spring for the linear engine and determine the best spring design by comparing the designed springs based on parameter of interest for the second stage of this project. Lastly, design the 3D model of linear engine where the third stage of this project.

CHAPTER 2

THEORITICAL BACKGROUND AND LITERATURE RIVIEW

2.1 Definition of Engine

An engine is a device which transforms one form of energy into another form. However, the efficiency of conversion plays an important role while transferring the energy from one form to another. Most of the engines convert thermal energy to the mechanical work which is another term called heat engines. Heat engine is a device which transforms chemical energy of fuel into thermal energy. This thermal energy is utilized to perform useful work. Thus, thermal energy is converted to mechanical energy in heat engine. Heat engines can be divided into the following two categories [7]:

i. Internal Combustion Engines (IC Engines)
ii. External Combustion Engines (EC Engines)

Engines whether Internal Combustion or External Combustion are of two types. The engines can be classified into the following types [7]:

i. Rotary engines
ii. Reciprocating engines

A detailed classification of heat engines is shown in Figure 2.1. The most widely used ones of heat engines are the reciprocating internal combustion engine, the gas turbine and the steam turbine. The steam engine is rarely used nowadays. The

reciprocating internal combustion engine has some advantages over the steam turbine because of the absence of heat exchangers in the passage of the working fluid (boilers and condensers in steam turbine plant). This results in the mechanical simplicity and improve power efficiency of the internal combustion engine. Another advantage of reciprocating internal combustion engine over the other type of engines is that very high working fluid temperature in the cycle of reciprocating engine can be employed resulting in higher thermal efficiency. Furthermore, in internal combustion engines, higher thermal efficiency can be obtained with moderate maximum working pressure of the fluid in the cycle, and therefore, the weight to power ratio is less than that of the steam turbine plant. Also it is possible to develop reciprocating internal combustion engines of very small output with very reasonable thermal efficiency and cost [7][19].

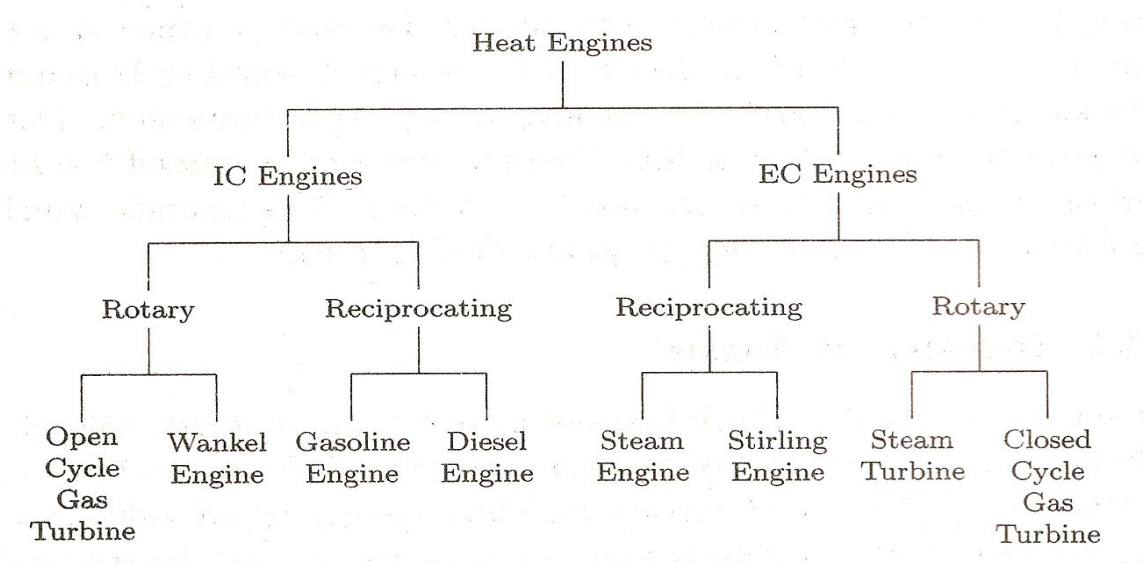

Figure 2.1 Detailed Classifications of Heat Engines [7]

The main disadvantage of this type of engine is the problem of vibration caused by the reciprocating components. Also, only certain liquid or gaseous fuels of given specification can be efficiently used. This fuel is relatively more expensive nowadays because the source of the fuel is depleting due to increasingly usage of this fuel in the whole world. The reciprocating internal combustion engines have been found suitable

for use in automobiles, motorcycles and scooters, power boats, ships, slow speed aircraft, locomotives and power units of relatively small output [7].

2.2 Basic Engine Components and Nomenclature

Even though the reciprocating internal combustion engines look quite simple, they are highly complex machines. There are hundreds of components which have to perform their functions satisfactorily to produce output power. So this chapter will go through the important engine components and nomenclature associated with the spark ignition engines [7].

2.2.1 Engine Components

Figure 2.2 shows a cross section of a single cylinder spark-ignition engine with over-head valves. The major components of the engine and their functions are briefly described below [7].

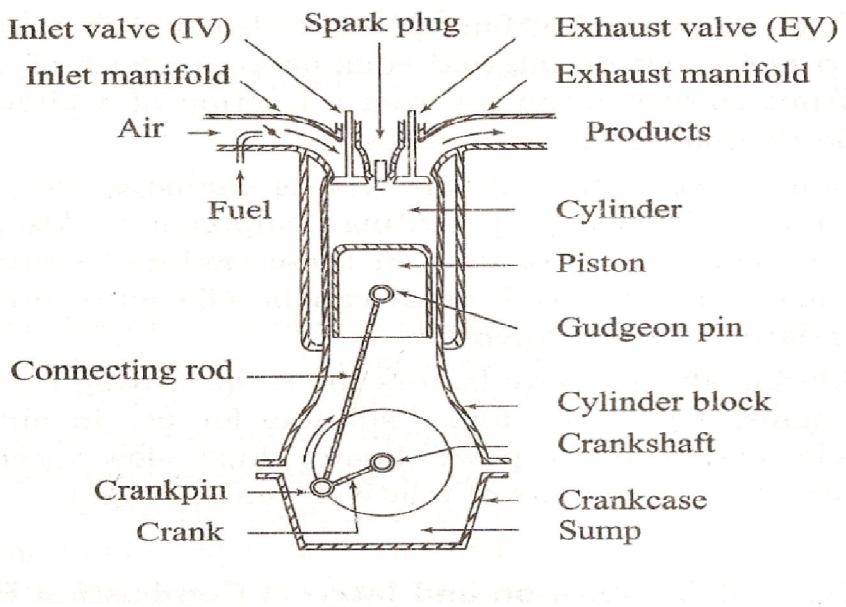

Figure 2.2 Cross Section of a Single Cylinder Spark-Ignition Engine [7]